Alaska's Spruce

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Preface

This booklet on Alaskan Sitka and white spruce describes the principal commercial timber trees of the State. It gives pertinent information about the characteristics, properties, and present and potential uses of native woods to foster better utilization and more widespread acceptance of Alaska's principal forest resources.

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Introduction

The spruce is the major forest tree of Alaska It has the widest distribution, reaches the largest size, and has the greatest commercial value of all species in the State. The majestic Sitka spruce, the Alaska State Tree, is a principal inhabitant of the deep rain forests of southeastern and south-central coastal Alaska In the vast forested areas of the interior Alaska, white spruce dominates. Black spruce plays a major role in providing cover in the muskeg and tundra areas of the State. Because of its small size and low commercial value, black spruce is not covered in this publication.

Sitka and white spruce constitute more than half of the total sawtimber volume in the State. Sitka spruce represents over 35 percent of the commercial sawtimber in the coastal timber stands, and white spruce sawtimber constitutes over 80 percent of the total sawtimber in the interior.

Sitka spruce is the monarch of the coastal forest The wood of the tree has long been recognized for its superior qualities, and its uses range from aircraft construction to piano sounding boards. White spruce, which is found in abundance in the valley floors near the great rivers of Alaska, is a smaller tree. Its wood has excellent qualities and finds uses ranging from high-grade pulpwood to construction. Of all the superior qualities of these two fine woods, the exceptionally high strength-to-weight charcteristic is the most notable. Many strength properties of spruce exceed structural steel and aluminum per weight.

Although a substantial quantity of Alaska's spruce is presently being used, especially Sitka spruce, only a relative minor amount finds acceptance and use within the State. At the same time, rather large volumes of forest products, ranging from lumber and plywood to piling, are shipped into Alaska to supply the growing local market. In the past, local suppliers have been few, and Alaskan markets have not been adequate to support efficient and complete Alaska manufacture. In some cases, low quality and poorly manufactured products coupled with high prices have turned contractors and others to imported timber.

This situation is changing. Alaska now has producers who can supply to Alaskans well-manufactured lumber products as well as other acceptable forest products, such as turned houselogs and poles at competitive prices.

This pamphlet has been prepared to acquaint the contractor, the industrial manufacturer, the homeowner, and other wood users with the characteristics, properties, and use of two of Alaska's major trees. It demonstrates that spruce is an excellent wood and in many typical uses is equal or superior to other woods commonly used in the State.

Botanically Sitka and white spruce are closely related. In areas where their ranges overlap, such as on the Kenai Pennisula, they have been found to hybridize. The properties and characteristics of the woods are very similar, and many of the uses of these two spruces are the same.

Characteristics of the Tree

Sitka Spruce

The scientific name of Sitka spruce is *Picea sitchensis*. Botanically, it is closely related to the white spruce of the interior and the Englemann spruce of the Rocky Mountains. It is the largest of all the spruces and the most valuable species in Alaska. In the State, an average Sitka spruce is about 0.9 meter in diameter and 45.7 meters tall, although many are 1.8 to 3.1 meters in diameter and 61 meters tall. The largest known Alaskan Sitka spruce 4.4 meters in diameter.

Sitka spruce is found in the coastal rain forest of southeastern and south-central Alaska from Ketchikan to Cook Inlet, extending into the Kodiak Island group. It is generally found in association with western hemlock, except in the westward extreme of its range. Sitka spruce is rarely found more than a short distance from the sea. And, it rarely grows at elevations above 900 meters.

Sitka spruce generally has a tall, straight, clear trunk. It tapers evenly above an enlarged base to an open conical crown. In open areas, the tree will occasionally grow bushy with large limbs touching the ground. The needles of Sitka spruce are sharp-pointed, flattened, dark green, and 16 to 25 millimeters long (fig. 2). The dark purplish-brown bark is scaly but relatively smooth and thin.

The cones are short-stalked, hang down, cylindrical, 5.1 to 8.9 centimeters long, and light orange-brown. They fall at maturity. Cone scales are long, stiff, thin, rounded, and irregularly toothed. The seeds are brown and about one-half inch in length, including the wings.

White Spruce

The scientific name of white spruce found in Alaska is *Picea glauca Var. albertiana*. This western variety is closely related to the eastern white and red spruce, the Englemann spruce of the Rockies, and the coastal Sitka spruce. The tree is medium in size. In high-quality stands, average trees are 30 to 60 centimeters in diameter and 15 to 25 meters in height. The largest known white spruce is 1.4 meters in diameter.

White spruce is the dominant tree and the only softwood of commercial significance in the interior. It ranges along all of the major drainages through most of north-central and western Alaska south of the Arctic slope. White spruce is the northernmost tree of commerical importance in North America. In Alaska, it is found in association with black spruce, white birch, cottonwood and aspen. It occurs from near sealevel to tree line at about 300 to 1,000 meters in elevation.

The crown of white spruce is generally narrow and spire-like, composed of drooping, short branches, which frequently extend along much of the trunk. It is often straight and tapers evenly. The gray bark is thin and scaly. The needles are stiff, four-angled and 13 to 19 millimeters in length. The needles are blue-green with whitish lines on all sides. Needles and twigs have a skunklike odor when crushed.

The cones are nearly stalkless, hang down, cylindrical, 3.2 to 6.4 centimeters in length, and shiny light-brown. They fall at maturity. The cone scales are thin and flexible with nearly straight margins and no teeth. The seeds are brown, and 9.5 millimeters long, including the wings.

Characteristics of the Wood

Sitka Spruce

Sitka spruce is one of the most desirable softwood in the world. The color of the wood ranges from creamy white (sapwood) to light pink (heartwood). It is light in weight, is nonporous, and has a fine, moderately even texture. The wood is generally very straight-grained. Because of the frequent great size of the tree and its clear trunk, it produces a large proportion of clear lumber suitable for special uses. Knots, when present, are generally sound. Sitka spruce has little taste or odor.

The wood is easily worked and planes to a smooth, silvery surface (see Appendix I). Its nail-holding ability is good, and it glues easily and takes paint, stain and varnish well. The wood dries easily in kilns or drying yards with only moderate shrinkage (table 7). The long, slender and light-colored fiber of Sitka spruce is desirable for high-grade pulp.

Major assets of Sitka spruce are its exceptional strength-to-weight ratio, its resistance to splintering or shattering on impact, and the large proportion of clear lumber available. It has proven especially valuable for aircraft frames, sailboat masts, ladder stock, and similar uses (table 1). It is noted for its resonance qualities, making it a preferred wood for musical instruments. Sitka spruce lumber is perfectly suitable for building frame construction. Of course, care must be taken in using it in moist environments without painting or preservative treatment.

White Spruce

White spruce is a widely used softwood, especially in Canada and the eastern United States. The wood of white spruce is light in color, varying from white to pale yellow. There is little contrast between the heartwood and sapwood. It is nonporous and light in weight. White spruce is almost tasteless and colorless. The wood is moderately soft and is noted for its good resonance qualities. The wood fibers are long, slender, and light in color.

White spruce machines and slices well to a smooth finish. It has good nail-holding properties and does not tend to split. It is very easy to glue and takes and holds paint and varnish well. In drying, it has a low-to-moderate shrinkage (table 7), and after seasoning, it has excellent dimensional stablity. White spruce can be rapidly and easily air dried or kiln dried.

Although the wood in generally found with knots, they are small and tight. Of moderate strenth, white spruce is noted for an especially high stength-to-weight ratio. It also is noted for its resiliency and gives good service in ordinary construction (table 1). Unless treated, white spruce should not be used in moist situations favorable to decay.

Table 1—Uses and qualities of spruce

Some typical uses*	Superior qualities of Sitka and white spruce *
Ladders, paddles, oars and scaffolding planks (mast and spars and aircraft construction).	High strength-to-weight, light weight and high resiliency (straight grain and clear wood).
Musical instruments, guitar stock and organ pipes (piano sounding boards).	Excellent resonance qualities, machines and finishes well, and low shrinkage. (straight grain and clear wood.
Pulp and paper.	Long, slender, light-colored fibers. Pulps easily.
Veneer and plywood.	Slices to a silky smooth finish, glues well, and high strength-to-weight.
Food containers and boxes.	Tasteless, odorless and works well.
Light and medium general construction.	Moderate strength, high resiliency, good nail-holding ability, easily dried and low shrinkage.

*The information in parentheses relates mostly to Sitka spruce because of the availability of large, clear, straight-grained lumber.

Average Properties of the Woods

Many of the values in this section have been derived form direct measurements made on spruce samples from Alaska (**5**). Others come from average properties of Sitka and white spruce from various areas in North America. A comparison between spruce from Alaska and other regions is made in this reference.

Weights

Log weights in tables 3 and 4 are approximate. Variables, such as density, moisture content, bark, choice of log rule, and so forth, affect this weight. This information is based on a log weight study conducted at Rodman Bay near Sitka in 1965 (**18**). Using Huber's Cubic Foot Log Rule, the study determined an average weight of 752.9 kilograms per cubic meter for Sitka spruce logs. The log weights where computed from this average (tables 3 and 4) using the Huber rule. The weights per thousand boardfeet measure (M bm) (Scribner) (tables 5 and 6) were determined directly during the study. White spruce log weights were computed arithmetically from the Sitka

spruce weights found during the study. A weight of 560.7 kilograms per cubic meter (Huber) (table 2) was used. The scaling diameter is taken inside the bark at the small end of the log.

Table 2—Average weight of solid wood

Type of wood	Sitka spruce	White spruce
	Pounds per cubic foot	
Green	33	36
Seasoned 1/	30	31
Seasoned 2/	29	30

1/ Based on a moisture content of 15-19 percent.
2/ Based on a moisture content of 12 percent.

Table 3—Average weight of Sitka spruce logs by diameter

Scaling diameter of log	Weight of log by length of—		
	16 feet	26 feet	40 feet
Inches Pounds-			
12	700	1,300	2,300
18	1,500	2,700	4,500
24	2,600	4,100	7,500
36	5,600	9,600	15,600

Table 4—Average weight of white spruce logs by diameter

Scaling diameter of log	Weight of log by length of—			
	8 feet	12 feet	16 feet	20 feet
Inches		Pounds		
8	225	400	500	625
12	400	750	950	1,200
16	750	1,200	1,600	2,000
20	1,100	1,800	2,400	3,000

Table 5—Average log weight by volume and diameter using Scribner Decimal "C" Log Rule Scale

Scaling diameter of logs	Weight by M bm of— Sitka spruce	White spruce
Inches	Pounds	
8	14,000	14,500
12	11,000	11,500
16	9,000	9,500
20	8,100	8,500
24	7,500	7,800
36	6,200	—

Table 6—Average weight of lumber by volume and type

Type of lumber	Weight by M bm of— Sitka spruce	White spruce
	Pounds	
Rough:		
Green	2,800 -3,000	3,000 -3,200
Seasoned 1/	2,500 -2,600	2,600 -2,700
Surfaced: 2/		
Green	2,200 -2,400	2,300 -2,500
Seasoned 1/	1,900 -2,000	1,950 -2,100

1/ Based on moisture content of 15 to 19 percent.
2/ Based on new lumber standards for dimension lumber. Data from local Alaska producers.

Specific Gravity

The specific gravity of green Sitka and white spruce 0.37. The specific gravity is 0.40 for seasoned spruce with a moisture content of 15-19 percent.

Table 7—Shrinkage of Sitka and white spruce

Perspective	Shrinkage from green to seasoned wood with a moisture content of— 12 percent	15-19 percent
	Percent	
Across the grain (tangential) 1/	2.9	2.6
Thickness (radial) 1/	2.4	1.8
Length	.1	.1
Volume	5.7	4.5

1/ Based on flat-grained boards; reverse for quarter-sawn or edge-grained boards.

Thermal Insulating Qualities

Thermal conductivity is measured by a K value, which is the amount of heat in British Thermal Units (BTU's) that flows through a 1-inch thickness of wood, 1-foot square in area, with a temperature difference of 1° F between the two surfaces. For Sitka and white spruce, the K value is 1.09-1.49 BTU's for green wood with a moisture content of 40 percent; 0.82-0.87 BTU for seasoned wood with a moisture content of 12 percent; and 0.68-0-72 BTU for oven-dried wood with no moisture.

Thermal resistance is measured by an R value, which is a direct measure of the insulating value, or the reciprocal of conductivity (K). For Sitka and white spruce, the R value is 0.92 for green wood with a moisture content of 40 percent. It is 1.15 for seasoned wood with a mositure content of 12 percent.

The overall coeffiecent of heat transfer or the U factor, takes into account the resistance of each component making up a wall or assembly and is used to measure and compare the insulating qualities of various forms of construction. Table 8 shows the U factor determination for a solid spruce wall, 8 inches thick, as commonly used in sawn houselog cabin construction. The wood is air-dried to a moisture content of 12 percent.

Table 8—U factor determination for a spruce log cabin wall

Elements	Thermal resistance of— Sitka spruce 1/	White Spruce2/
	U factor	
Outside air	0.17	0.17
8-inch solid wood	9.19	9.75
Inside air	.68	.68
Total	10.04	10.60

1/ U = 1 / Total R = 0.10 BTU/hr./sq.ft./F° temperature difference.

2/ U = 1 / Total R = 0.09 BTU/hr./sq.ft./F° temperature difference.

Electrical Insulating Qualities

The most important electrical property of wood is its resistance to the passage of electrical current. It is especially important in connection with the use of wood in power poles and ladders, common uses for spruce. This resistance varies greatly with moisture content.

Table 9 shows some average electrical resistances of Sitka spruce at different values of moisture content. White spruce is similar. These resistances are along the grain, measured at 80°F between two pairs of needle electrodes 1-¼ inches apart and driven to a depth to 5/16 inch.

Table 9—Electrical resistances of Sitka spruce

With a moisture content of—	Resistance
Percent	Megohms
7	22,400.00
8	5,890.00
12	165.00
18	6.30
25	.71

Table 10—Strength values and mechanical properties of Sitka and white spruce

	Sitka Spruce		White spruce	
Item	Green	Seasoned	Green	Seasoned
Hardness -Load required to embed a 0.444-inch ball to one-half its diameter (lbs.):				
End grain	430	800	370	640
Side grain	350	510	320	480
Static bending (psi):				
Fiber stress at elastic limit	3,350	6,900	3,200	6,700
Modulus of rupture	5,700	10,200	5,600	9,800
Modulus of elasticity	1,230,000	1,570,000	1,070,000	1,340,000
Work to elastic limit	.54	1.68	.51	1.83
Work to maximum load	6.30	9.40	6.00	7.70
Impact bending -Heights of drop causing complete failure -50 lb. hammer (inches)	24	25	22	20
Compression parallel to the grain (psi):				
Fiber stress at elastic limit	2,260	4,750	2,150	4,750
Maximum crushing strength	2,670	5,610	2,570	5,470
Shearing strength parallel to grain (psi):	760	1,150	690	1,080
Tension perpendicular to the grain (psi):	250	370	220	360
Compression perpendicular to the grain (Fiber stress at elastic limit) (psi):	280	580	240	460

All strength properties of Sikta spruce and white spruce increase as the wood is dried The values in table 10 are based on test of small, clear speciments in green and air-dry conditions. (See table 15 for strength values of Sitka spruce and white spruce lumber.)

Board Sizes

Boards are defined as lumber that is less than 2 inches in nominal thickness, generally 1 inch. Table 11 gives the more common sizes for l-inch boards.

Table 11—Widths and depths of green and dry boards

For boards that have nominal depth of **1 inch by—**	Standard dry boards will be 3/4-inch **deep by—**	Standard green boards will be 25/32-inch **deep by—**
	Inches wide	
2	1-½	1-9/16
4	3-½	3-9/16
6	5-½	5-5/8
8	7-¼	7-½
10	9-¼	9-½
12	**11-¼**	**11-½**

Alaska Spruce for Construction

Alaskan spruce is an excellent structural wood for use in construction. It has an exceptionally high strength-to-weight ratio. It holds nails well, does not tend to split, easily planes and glues, and takes paint well. It is extremely resilient and it has excellent dimensional stability, dries easily, and has small tight knots.

The American Lumber Standard establishes uniform green and dry sizes and standard-dimension lumber grades for all species, including Alaskan spruce, throughout North America. A spruce stud manufactured in Alaska will be the same dimension and carry the same grade name and description as a southern pine or Douglas-fir stud

Standard sizes of yard lumber and timbers

New standards take into account the shrinkage of lumber during seasoning. Before this, the same sizes were standard for both green and dry lumber. And, if unseasoned framing lumber were installed in a house or other building, it would shrink to smaller widths and thicknesses. Under the new standards, unseasoned lumber must be surfaced larger to allow for this shrinkage. The difference is just enough so that when it shrinks, it will be equivalent in size and load capacity to lumber that was surfaced dry. Unseasoned or green lumber is defined as having a moisture content exceeding 19 percent.

Dimensional Lumber Size

Dimensional lumber—2 to 4 inches thick—is used mainly for floor joists, wall studs, and roof rafters of buildings. They are the principal load-carrying members in conventional construction. Table 12 illustrates the comparable dry and green sizes of 2-inch dimensional lumber.

Table 12—Dimension lumber sizes, in inches

Nominal size	Dry	Green
2 X 2	1-½ X 1½	1-9/16 X 1-9/16
2 X 4	1½ X 3½	1-9/16 X 3-9/16
2 X 6	1½ X 5½	1-9/16 X 5-5/8
2 X 8	1½ X 7¼	1-9/16 X 7½
2 X 10	1½ X 9¼	1-9/16 X 9½
2 X 12	1½ X 11¼	1-9/16 X 11½

Timber Sizes

Timbers are 5 inches or greater in thickness. They are usually sold unseasoned. The minimum thicknesses and widths are one-half inch smaller than the nominal sizes. An example of this follows in table 13.

Table 13 - Timber sizes, in inches

5 X 5	4½ X 4½
6 X 8	5½ X 7½
8 X 8	7½ X 7½
6 X 10	5½ X 9½

The American Lumber Standard (PS 20-70–UNSCR1– also includes a National Grading Rule for Dimension Lumber. These uniform and simplified grades are geared to the needs of the builder and the user. All dimension lumber (2 to 4 inches thick), regradless of the species or source, bears the same grade name and description. Grades for boards and timbers will continue to be established by a regional grading association. In the case of Sikta spruce, the West Coast Lumber Inpsection Bureau (WCLIB) is that association.

The Northeastern Lumber Manufacturers Association (NELMA) and the Northern Hardwood and Pine Manufacturers Association (NHPMA) include white spruce in their grades under "Eastern Spruces". In Canada, white spruce is graded and sold in a grouping with the commercial name "Spruce-pine-fir".

It is improbable that Alaska white spruce lumber producers will belong to those distant associations. White spruce will probably be graded either with a local mill grade or board grade developed by the western grading associations—Western Wood Products Association (WWPA) or West Coast Lumber Inspection Bureau (WCLIB)—for similar species.

Spruce Board Grades

Sitka spruce—Boards are under 2 inches in thickness. WCLIB board grades include grades for finish and other high-grade specialty lumber as well as common grade boards, sheathing, and form lumber. The following are the more common grades applied to 1-inch lumber.

Board grades:

Selects or Finish—"B and Btr," "C," and "D."
Commons—No. 1, No. 2, No. 3, and No. 4 **or** "Select Merchantable," "Construction, "Standard," "Utility," and "Economy."

Spruce Dimension Lumber Grades

Spruce dimension lumber is graded under the National Grading Rules. These are stress grades which mean that the growth features, for example, grain, pattern, knots, and so forth, permitted in each grade are scientifically limited to provide safe and reliable performance. The strength and stiffness values associated with these stress grades are used by engineers and architects to design safe, economical structures.

These grades cover five categories. Within the categories are several grades which directly relate to the strength characteristics of the piece. The categories and grades are shown in table 14.

These grades are for visually graded lumber. The lumber should bear a graded stamp giving the name of the grade and the species. The grade stamp should also indicate "S-grn," if the lumber has been surfaced before seasoning, or "S-dry," if surfaced after drying, so that the dimension can be checked. In addition to these visual grades, the National Grading Rules for Dimension Lumber have established uniform stress grades for machine stress-rated dimension lumber

Table 14—Grades of dimension lumber

Category	Uses	Grades
1. **Structural Light Framing (2-to-4 inches** thick 2-to-4 inches wide).	For trussed rafters and engineering uses.	Select Structural No. 1, No. 2, and No. 3.
2. **Light framing** (2-to-4 inches thick, 2-to-4 inches wide).	For house framing and and general construction.	Construction Standard and Utility.
3. **Studs** 2-to-4 inches thick, 2-to-4 inches wide, 10 feet and shorters).	For vertical framing of interior and exterior walls, both load-bearing and nonload-bearing.	Stud.
4. **Structural Joist and Plank (2-to-4 inches** thick, 6 inches wider.	For construction uses where heavier loads or longer spans are involved.	Select Structural No. 1, No. 2, and No. 3.
5. **Appearance Framing (2-to-4 inches** thick, 2 inches and wider).	For exposed lumber where appearance is as important as strength.	Appearance.

Timber Grades

Sitka spruce—WCLIB rules apply for Sitka spruce. They are as follows: Beams and Stringers, Post and Timbers—"Select Structural," "No. 1 Structural," "Standard," and "Utility."

White spruce—Regional association grading rules apply (see grading of white spruce board). The more common softwood grades for timbers are as follows:

Select structural—No. 1, No. 2, and No. 3; **or**

Select structural—No. 1 Structural, Standard, and Utility.

These grades are for visually graded lumber. The lumber should bear a graded stamp giving the name of the grade and the species. The grade stamp should also indicate "S-grn", if the lumber has been surfaced before seasoning or "S-dry", if surfaced after drying so that the dimension can be checked.

In addition to these visual grades, the National Grading Rules for Dimension Lumber have established uniform stress grades for machine stress-rated dimension lumber.

Allowable Property Values for Structural Grade Spruce Lumber

Clear wood property values for spruce determined by the USDA Forest Products Laboratory have included both Alaska Sitka spruce and white spruce samples. Property values (allowable or working properties) for stress graded lumber are determined from these basic values. In the United States, Sitka spruce is rated and sold commercially by itself, and white spruce is rated and sold grouped together with red and black spruce as "Eastern Spruce."

Allowable properties for spruce stress-graded lumber are given in the grade rules and in "National

Design Specifications" published by the National Forest Products Association. They also publish recommended working stress values for load-carrying floor and roof members. This information can be found in NFPA's "Working Stresses for Joists and Rafters." These allowable properties have also been accepted by the Federal Housing Authority, by model codes, and are used by architects, engineers, and builders.

Allowable Unit Stresses for Structural Spruce Lumber

Table 15's allowable unit stresses are taken from the November 1970 supplement to "National Design Specifications for Stress Graded Lumber and Its Fasteners," as recommended by the National Forest Products Association. (Allowable units stresses listed are for normal loading conditions. Adjustment factors are available for flatwise use, changes in moisture content, and other conditions.)

Table 15—Allowable unit stresses for Sitka spruce and white spruce structural lumber by visual grading

Allowable unit stresses in pounds per square inch [1/]

Species and commercial grade	Size classification	Extreme fiber in bending "F" b: Engineered uses (singles)	Extreme fiber in bending "F" b: Repetitive member uses[2/]	Tension parallel to grain "F" t	Horizontal shear "F" v	Compres. prpndicular to grain "F" cT	Modulus parallel to grain "F" c	Grading of elasticity "E"	rules agency
Sitka spruce (surfaced dry or surfaced green. Used at 19 percent maximum moisture content.):									
Select structural	2 to 4 inches	1,550	1,800	925	75	280	1,150	1.5	West Coast
No. 1	thick;	1,350	1,550	775	75	280	925	1.5	Lumber
No. 2	2 to 4 inches	1,100	1,250	650	75	280	725	1.3	Inspection
No. 3	wide.	600	700	350	75	280	450	1.2	Bureau.
Appearance	Do.	1,350	1,550	750	75	280	1,100	1.5	Do.
Construction	Do.	800	925	475	75	280	825	1.2	Do.
Standard	Do.	450	500	250	75	280	675	1.2	Do.
Utility	Do.	200	250	125	75	280	450	1.2	Do.
Studs	Do.	600	700	350	75	280	450	1.2	Do.
Select structural	2 to 4 inches	1,350	1,550	900	75	280	1,000	1.5	Do.
No. 1	thick;	1,150	1,300	775	75	280	925	1.5	Do.
No. 2	6 inches and	925	1,050	625	75	280	775	1.3	Do.
No. 3	wider.	525	600	350	75	280	500	1.2	Do.
Appearance	Do.	1,150	1,300	750	75	280	1,100	1.5	Do.
Select structural	Beams and	1,200	—	675	70	280	825	1.3	Do.
No. 1	stringers.	1,000	—	500	70	280	675	1.3	Do.
Select structural	Posts and	1,150	—	750	70	280	875	1.3	Do.
No. 1	timbers.	925	—	600	70	280	750	1.3	Do.
Select dex	Decking.	1,300	1,500	-	—	280	—	1.5	Do.
Commercial dex	Do.	1,100	1,250	-	—	280	—	1.3	Do.
White spruce (surfaced at 15 percent moisture content. Used at 15 percent maximum moisture content.):									
Select structural	2 to 4 inches	1,650	1,900	950	70	265	1,350	1.4	Northeastern
No. 1	thick; 2 to	1,400	1,600	800	70	255	1,050	1.4	Lumber
No. 2	4 inches	1,150	1,300	675	70	255	825	1.3	Manufac-
No. 3	wide.	625	725	375	70	255	500	1.2	turers
Appearance	Do.	1,200	1,350	800	70	255	1,250	1.4	Association
Construction	Do.	825	950	475	70	255	950	1.2	and
Standard	Do.	450	525	275	70	255	775	1.2	Northern
Utility	Do.	200	250	125	70	255	500	1.2	Hardwood
Studs	Do.	625	725	375	70	255	500	1.2	and Pine
Select structural	2 to 4 inches	1,400	1,600	950	70	255	1,150	1.4	Manufac-
No. 1	thick; 6	1,200	1,350	800	70	255	1,050	1.4	turers
No. 2	inches and	950	1,100	650	70	255	875	1.3	Association.
No. 3	wider.	575	650	375	70	255	550	1.2	Do.
Appearance	Do.	1,200	1,350	800	70	255	1,250	1.4	Do.
White spruce (surfaced dry or surfaced green. Used at 19 percent maximum moistu content.):									

—Continued

Select structural	2 to 4 inches	1,500	1,750	875	65	255	1,150	1.4	Northeastern
No. 1	thick; 2 to	1,300	1,500	750	65	255	900	1.4	Lumber
No. 2	4 inches	1,050	1,200	625	65	255	700	1.2	Manufac-
No. 3	wide.	575	675	325	65	255	425	1 1	turers
Appearance	Do.	1,100	1,250	750	65	255	1,050	1.4	Association
Construction	Do.	775	875	450	65	255	800	1.1	and
Standard	Do.	425	500	250	65	255	675	1.1	Northern
Utility	Do.	200	225	100	65	255	425	1.1	Hardwood
Studs	Do.	575	675	325	65	255	425	1.1	and Pine
Select structural	2 to 4 inches	1,300	1,500	875	65	255	1,000	1.4	Manufac-
No. 1	thick; 6	1,100	1,250	750	65	255	900	1.4	turers
No. 2	inches and	900	1,000	600	65	255	750	1.2	Association.
No. 3	wider	525	600	325	65	255	475	1.1	Do.
Appearance	Do.	1,100	1,250	750	65	255	1,050	1.4	Do.
Select structural	Beams and	1,150	—	775	60	255	800	1.2	Do.
No. 1	stringers	950	—	650	60	255	675	1.2	Do.
Select structural	Posts and	1,100	—	725	60	255	850	1.2	Do.
No. 1	timbers.	875	—	725	60	255	850	1.2	Do.
Truss	2 to 4 inches thick; 2 to 4 inches wide.	1,785	2,050	1,000	65	255	1,200	1.4	Northeastern Lumber Manufac- turers
1,500f	2 to 4 inches thick, 6 inches and wider.	1,500	1,700	1,000	65	255	1,100	1 4	Association.
Select	Decking	1,200	1,450	—	—	—	—	1 4	Do.
Commercial	Do	1,050	1,200	—	—	—	—	1.4	Do

[1] For snow loading not exceeding 2 months in duration, all stresses may be increased 15 percent. For wind or earthquake loads, stresses may be increased 33 1/3 percent. These increases are not cumulative and do not apply to modulus of elasticity. (Other allowable increases: 7-day duration, 25 percent of value only in southern States where snow loads do not last more that 7 days, impact—100 percent, seldom used, special situations, such as bridges, maximum wind gusts, and so forth.)

[2] This column is used for repetitive members, such a joists and rafters, spaced not more than 24 inches on center.

Allowable Spans for Spruce Joists and Rafters

Once working stresses for various grades and species of dimension lumber are known, the allowable spans for joists and rafters at different spacings can be easily be found for any given width and grade of lumber. Span tables for joists and rafters, prepared by the National Forest Products Association (see referece 21) present this information based on the new American Lumber Standards (PS-20-70) sizes and grades. Table 16 shows some of the common spruce grades, sizes, and maximum allowable floor, joist spans:

Table 16—Sizes, grades, and spans of spruce joists

Size	Grade 1/	Maximum allowable floor joist span 2/	
		Sitka spruce	White spruce
Inches	Kind	Feet/inches	Feet/inches
2 X 6	Select Structural	9 - 4	9 - 4
	No. 1 and Appearance	9 - 6	9 - 4
	No. 2	8 - 10	8 - 7
	No. 3	8 - 7	6 - 7
2 X 8	Select Structural	12 - 7	12 - 3
	No. 1 and Appearance	12 - 7	12 - 3
	No. 2	11 - 8	11 - 4
	No. 3	8 - 9	8 - 9
2 X 10	Select Structural	16 - 0	15 - 8
	No. 1 and Appearance	16 - 0	15 - 8
	No. 2	14 - 11	14 - 6
	No. 3	11 - 1	11 - 1
2 X 12	Select Structural	19 - 6	19 - 1
	No. 1 and Appearance	19 - 6	19 - 1
	No. 2	18 - 1	17 - 7
	No. 3	13 - 6	13 - 6

1/ Surfaced dry or surfaced green; moisture content at 19 percent.
2/ 40 pounds per square foot, live load, joist spacing—16 inches.

Alaska Spruce for Poles and Pilings

Sitka and white spruce have strength characteristics that make them suitable for use as poles for both utility and construction applications. When used in contact with the ground, preservative treatment is necessary for maximum life. As new and more effective preservative treatments are developed for spruce, its importance as a pole source will become greater in Alaska.

Both Sitka and white spruce are included in the "American Standard Specifications and Dimensions for Wood Poles" (ANSI 05.1 -63). These woods are in the Fiber Stress Rating Class of 6,600 psi. This is the same class as lodgepole, jack and red pine, and redwood and western fir. It is a stronger rating than that carried by some other

common pole timber, such as red and white cedar and Engelmann spruce.

Based on this Fiber Stress rating of 6,600 psi, ANSI 05.1 gives minimum dimensions for various classes and lengths of poles. A few of the more common values are shown in table 17.

Table 17—Minimum dimensions of spruce poles

Class of pole (Numbers)	2	4	6
Minimum circumference at top (inches)	25.0	21.0	17.0
Minimum Circumference (inches) at (6 feet from butt when the length of a pole is—			
25 feet	33.5	29.0	25.0
30 feet	36.5	31.5	27.0
40 feet	41.0	35.5	30.0
60 feet	48.0	42.0	36.0

These poles must also meet other requirements. Defects, such as cracks, shake, spiral grain, crook, and sweep, are considered. If preservatively treated, the poles would also have to meet the specifications required for treated wood.

Spruce is suitable in many piling applications. As with poles, piling used in contact with the ground or in marine use should be treated with preservatives for full life. Piling is usually classified into two groups: Foundation and general construction, and marine construction. Marine piling usually requires a very heavy preservative treatment, something that at this time is difficult with spruce.

Specifications for spruce piling can be found in the "American Society for Testing and Materials-Standard Specifications for Round Timber Piles" (ASTM D 25-70). In these specifications, piles are classified into three use classes considering such uses as heavy bridge construction, building foundations, docks, or light construction. Spruce is grouped with other softwoods, such as Douglas-fir, hemlock, and pine. Specifications for spruce piling can also be found in "Federal Specifications for Pile, Wood MM-P-371b; Specifications for Highway Materials, ASSHO M 168-57;" and in specifications published by the American National Standards Institute.

All of these specifications give minimum butt and top diameters for various lengths and classes of piling as well as other criteria, such as straightness, allowable defects, and general quality. An example of dimension specifications for **Class C** spruce piling for light construction follows in table 18.

Table 18—Dimension specifications for spruce piling

Length	3 feet from butt: Minimum circumference	3 feet from butt: Maximum circumference	Minimum circumference at tip
		Inches	
Under 40 feet	38	63	25
40 to 50 feet	38	63	22
51 to 70 feet	41	63	22
71 to 90 feet	41	63	19

Preservative Treatment of Alaska Spruce

Preservatives are extensively used to protect wood from attacks by fungi, insects, and marine borers. The uses of preservatively treated wood in Alaska have grown considerably in recent years. In the past, many structures in this State, such as canneries, bridges, and railroads, were constructed on untreated piling, posts, or timbers. Many untreated utitlity poles still exist in the State. Today, with the high construction cost for these structures, and with the availability of treated timber, the use of preservative treated wood in conditions subject to decay or by attack from borers has become much more common.

Difficulties are encountered in obtaining satisfactory treatment with spruce using conventional pressure preservative treatment processes. Erratic penetration of the preservative is usually experienced.

Because of this, the American Wood Preservers' Association Standards for this type of treatment do not include white or Sitka spruce.

Samples of Alaskan white and Sitka spruce were tested in 1971 by the USDA Forest Products Laboratory at Madison, Wisconsin, using a process called double-diffusion. This treatment process does not require pressure retorts, but it achieves penetration using green material in soaking tanks.

To prevent decay of spruce timber, a preservative solution can be applied by the crush, dip, or cold-soak methods. This treatment does not give the extended protection that the deep preservative penetration methods do, and it must be reapplied with some frequency. If wood treated by these methods is not used in contact with the ground and is protected so that it does not stay damp for extended periods of time, the service life can be extended considerable. This type of treatment is commonly used for millwork, window sash, porch post, and decking where the wood used is somewhat protected form the weather.

Several commercial preservatives of this type are available. Some come in a concentrated form and may be mixed with a solvent before use. The chemical compositions vary, but most include a toxic chemical, such as copper

naphthenate or pentachlorophenol, and a water repellent. They are described in Federal Specifications TT-W-572 and Commercial Standards CS 262-63. The preservative solutions can be applied directly by brushing or by dipping or soaking. Heating the solution can increase the penetration. Common trade names are Cuprinol, Penta, Woodlife, Wootox, and others. The directions given by the manufacturers should always be followed.

As mentioned, direct contact with the ground should be avoided. A good rule of thumb is to keep the wood at least 8 inches away from the ground. The surface of the wood should be kept clean. Buildup of moss and dirt or the formation of water pockets should be prevented. Periodic applications of the preservative with a brush are beneficial.

The double-diffusion method of treatment has shown promise for obtaining deeper penetration of the preservative in spruce. Some of the publications listed at the back of this brochure describe this relatively simple process.

Alaska Spruce for Loghouse Construction

Log house construction is popular in Alaska. In many cases this type of structure can be built from locally available materials at a relatively low cost. If properly constructed, a log building is very satisfactory and presents a pleasing, rustic appearance which fits the Alaskan environment. Spruce is the most commonly used wood for log houses. It is readily available throughout much of Alaska in the size and form necessary. Its workability, strength, weight, and insulating qualities make it an excellent choice for a log house wall.

Natural or unshaped houselogs—These logs are used as they come from the tree. They can be used in wall construction or for rafters, joists, and so forth. The limbs are cut flush, and the bark should be removed to discourage decay and insect attack. Straight, smooth, even-sized logs are a prime consideration. Diameters should be as uniform as possible, and the logs should have a minimum taper. In wall construction, the alternate logs are commonly reversed end-for-end to compensate for this factor.

The advantages of natural houselog construction are twofold. When lumber and other building materials are not readily available and it is impractical to move large quantities of building materials to the site, this can be a practical type of construction. This is especially true in remote areas of Alaska. The other advantage is that a natural roundlog building requires a minimum amount of out-of-pocket cash. Individuals can usually obtain timber for personal use from State or Federal landholding agencies free or at a minimum charge.

The main disadvantages to natural houselog construction are that it takes time, hard work, and skilled craftsmanship. Enough good logs may be hard to find. A good weathertight fit takes considerable skill and several people are usually needed to raise a log house.

Joints between logs can be caulked with clay, moss, cement, or modern

caulking materials. Adequate insulating material should be used at joints to prevent interior frosting in cold climates (see figure 8).

Milled or turned houselogs—These are round logs that have been machined or turned to a constant size and shape. They are milled on a large lathe to a uniform diameter throughout their length. A number of mills in Alaska manufacture this type of turned houselog. A half-round cut is made along one face of the log to improve the fitting of one log on top of another and to provide a pocket for insulation. Half rounds are also sawn across the ends for fitting the saddle corners.

Turned houselogs are usually sold by the lineal foot in diameters that range from 6 to 10 inches. Eight-to-10-foot lengths are usually maximum. Some Alaskan manufacturers prepare precut packages for the wall construction of various size log homes.

The principal advantage of the turned houselog is ease of construction and good fit. Several people can easily erect the complete wall of a house in a few days. A home constructed with turned logs presents a very attractive appearance—rustic but neat.

Sawn or three-sided houselogs—This is another common form of house construction in Alaska, especially in the rural areas. The logs are rough-sawn on three faces on a sawmill (fig. 10). The thickness is kept uniform, and the top and bottom faces held to a certain minimum width, usually 6 inches or more. To make the wall, the sawn logs are placed on top of each other with the round side out. The inside surface is kept flush. Fiberglass or other insulation is placed between each course and the logs pinned together with long spikes. Dimension lumber and sometimes poles can be used for the rafters or joists. Lumber or plywood is used for sheathing.

Sawn houselog construction is much easier than using natural logs because of the flat surfaces. Fitting is simpler. The side lumber produced while sawing the tree-sided houselog for the walls can be used to construct the remainder of the house. The cost of the sawn houselog is usually lower than that of a turned log because of ease of manufacture. Commercially sawn houselogs are usually sold by the lineal foot. The interior wall is a flat surface, compared to the natural or turned roundlog wall, which facilitates further finishing of the interior walls. With the round face out, a rustic log cabin appearance is achieved.

Seasoning—Many houselogs are used green without any serious consequences. However, it is preferable to partly season them before construction. There are several reasons for this. Green wood will shrink in width or thickness from 2 to 4 percent as it reaches an air-dry moisture content. In an 8-foot or 10-foot wall, this shrinkage can be as much as 4 inches. If the logs are used green, doors, windows, and other fittings can be affected, and tolerances should be allowed at the tops. The temporary void should be packed with flexible insulation. If the log has any appreciable spiral grain, drying process will cause the log to twist. This can affect the fit and cause cracks. Logs with severe spiral grain should be avoided in any case. In the best use of houselogs, especially those turned or sawn, it is

important to allow the rough logs to season for at least one summer and preferable a year before milling them. Season off the ground and under cover, if possible.

Protection against decay, stain, and weathering—It is always advisable to remove the bark from houselogs as soon as possible after cutting the tree. The bark can harbor stain or rot-producing fungi and insects. Removing the bark will also speed the seasoning rate.

As in other types of construction, houselog buildings should always be placed on a good foundation well away from the ground to prevent decay. Masonry, concrete foundations, or piers can be used. If the piers are wood, they should be treated with a preservative. To retain the attractive rustic appearance of houselog construction and to reduce checking and staining, a finish material should be applied. Many finish materials are available, ranging from clear oils and varnishes to stains or paint.

Insulating qualities—In the North, insulating qualities of a house are especially important. In all types of houselog construction it is, of course, important that the cracks be fully sealed. The old methods of chinking with mud, moss, or plaster have now been largely replaced or improved upon by using strips of fiberglass or other modern insulation between each course of houselogs. The use of well-seasoned, stable logs is also important to hold the fit and prevent large cracks from opening up. Floors and ceilings are usually insulated by conventional method

The question frequently arises as to the insulating quality of a solid wood wall used in houselog construction. Seasoned spruce wood has good insulating qualities. Based on thermal conductivity and resistance values given, the U factor for an 8-inch solid-sawn houselog wall is approximately 0.10. U factors for an insulated, well framed wall range from 0.5 to 0.10 depending upon the thickness of the wall and insulation. Many solid wood walled homes are used throughout Alaska and are considered sufficiently warm, especially in the more moderate areas of the State. The addition of a furred interior wall with several inches of conventional insulation will make the insulation values of a solid houselog wall equal to the best insulated frame construction. Foamed plastic sheets can be fastened directly to the flat inside of sawn houselogs which eliminates the need for furring strips. Paneling or other wall covering can be fastened directly to the foamed plastic sheets.

Houselogs from sound dead trees—Houselogs are an excellent use of dead spruce trees. Because of bark beetle outbreaks in Alaska, there are vast acreages of standing dead white spruce. Trees that have been dead for 2 or more years and are still sound have dried substantially. Houselogs from these trees can be used as soon as cut with little or no effect from shrinkage. The logs weigh less, which makes handling easier. One possible disadvantage of using houselogs from dead trees is a darker color which may not be so pleasing to some users.

Appendix

Machining of Spruce

The soft springwood of the spruces requires sharp tools for good machining and slicing. Spruce lumber planned with dull tools tends to develop raised and fuzzy grain, particularly if the moisture content of the wood is 20 percent or higher. For spruce lumber dried to 12-percent moisture content or less and planned with sharp knives having a knife angle of about 30 degrees, a depth of cut of about 1/16 and 14 to 16 knife cuts per inch will have good surfaces.

Metric Conversion Needed

Multiply—	By—	To obtain—
Inches.	25.4	Millimeters.
Inches.	2.54	Centimeters
Inches.	.0254	Meters.
Square inches.	6.452	Square centimeters.
Square inches.	.06452	Square meters.
Feet.	30.48	Centimeters.
Feet.	.3048	Meters.
Cubic feet.	28,320	Cubic centimeters.
Cubic feet.	.02832	Cubic meters.
Pounds	453.59	Grams.
Pounds per cubic foot	16.02	Kilograms per cubic meter

References

(1) **Alaska Trees and Shrubs.** U.S. Dep. Agric., Agric. Handb. No. 410, 1972.

(2) **Building a Log House.** Publ. No. 28, Coop. Ext. Serv., Univ. Alaska, 1965.

(3) **Canadian Woods, Their Properties and Uses.** For. Br., For. Products Lab. Div., Canada Dep. Resour. and Develop., 1951.

(4) **Characteristics and Significance of Spruce.** K. G. Fensom, Canada Dep. North. Affairs and National Resour., Vancouver For. Products Lab., 1954.

(5) **Characteristics of Alaska Woods.** For. Serv. Research Paper, FPL 1, For. Products Lab., U.S. Dep. Agric., 1963.

(6) **Conversion Factors for Pacific Northwest Forest Products.** Inst. For. Products, Wash. State, 1957.

(7) **Cutting White Spruce Veneers for Plywood.** A. O. Fiehl, Canada Dep. North. Affairs and National Resourc., For. Products Lab., 1956.

(8) **Douglas Fir Plywood and other Softwood Plywoods, Construction Guide for Architects, Engineers, Builders and Building Code Officials.** Am. Plywood Assn., 1962.

(9) **Factors Affecting Lumber Recovery from Spruce in the Prince George Area of British Columbia.** C. F. McBride, Canada Dep. North. Affairs and National Resour., Vancouver For. Products Lab., 1956.

(10) **Hough's Encyclopedia of American Woods.** E. S. Harrar, Robert Speller & Sons: New York, 1957.

(11) **How to Treat Fence Posts by Double-Diffusion.** R. H. Baechlor, U.S. Dep. Agric., For. Serv., For. Products Lab., 1963.

(12) **National Design Specifications for Stress-Grades Lumber and Its Fasteners.** Nov. 1970 suppl. to 1968 edition, National For. Products Assoc.

(13) **National Forest Log Scaling Handbook.** U.S. Dep. Agric., For. Serv. Handb. 2409.11.

(14) **1970 Standard Grading Rules for Western Lumber.** West. Wood Products Assn., 1970.

(15) **Pocket Guide to Alaska Trees.** U.S. Dep. Agric., Handb. No. 5, 1950.

(16) **Preservative Retention and Distribution in Several Western Conifers.** J. O. Blew, H. G. Roth, and H. L. Davidson, U.S. Dep. Agric. For. Products Lab., Am. Wood Preservers Assoc. Reprint, 1967.

(17) **Preserving Wood by Brush, Dip, and Short Soak Methods.** Technical Bulletin No. 1334, Forest Service, USDA, May 1965.

(18) **Report on a Study of Log Weight Estimates.** K.J. Turnbull, L.F. Pienaar, and I.E. Bella, University of Washington College of Forestry, May 1965.

(19) **Sitka Spruce Lumber, Its Properties and Uses.** West Coast Lumberman's Association, Portland, Oregon.

(20) **Sitka Spruce.** Useful Trees of the United States Series, USDA, Forest Service, Revised June 1954.

(21) **Span Tables for Joists and Rafters - American Softwood Standard Sizes PS 20-70.** National Forest Products Association, October 1970.

(22) **Standard Grading Rules for West Coast Lumber,** No. 16. West Coast Lumber Inspection Bureau, effective September 1, 1970.

(23) **Treating Resistant Rocky Mountain Species by Regular and Modified Double-Diffusion Methods.** D.S. Martstrom, L.A. Mueller, and L.R. Gjovik. Paper presented at 1970 annual Forest Products Research Society meeting. (Copies may be obtained from the USDA Forest Products Laboratory, Box 5130, Madison, Wisconsin 53705.)

(24) **Western White Spruce - Lodgepole Pine - Douglas Fir.** Cariboo Lumber Manufacturers Association, Williams Lake, British Columbia, Canada.

(25) **Wood Handbook.** Forest Products Laboratory, Agriculture Handbook No. 72, Revised August 1974.

(26) **Working Stresses for Joists and Rafters Recommended by National Forest Products Association.** National Forest Products Association, October 1970.

Chemical Precautionary Statement

Pesticides and chemicals can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides and chemicals selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers. Mention of a pesticide or chemical in this publication does not constitute a recommendation for use by the USDA, nor does it imply registration under the Federal Insectcide, Fungicide, and Rodenticide Act, as amended. Mention of a proprietary product does not constitute an endorsement by the USDA.

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